corporations and others distributing electrical energy. In course of time the benefits to the electrical industry at large, which will certainly follow the adoption of these standard pressures, must become more and more apparent.

A circular was drafted embodying the suggestions of the subcommittee, and this was submitted, first to the manufacturers for their consideration, and secondly to the leading consulting engineers and users of motors.

The information so courteously placed at the disposal of the subcommittee by the consulting engineers and manufacturers was most carefully weighed and considered by the subcommittee, and certain definite conclusions were arrived at, the circular being sent, in the first instance, to the manufacturers, as they were the people most directly interested. Replies were received from all the leading firms, who expressed themselves unanimously in favour of the recommendations of the subcommittee. The consulting engineers similarly gave their adherence to the proposals of the subcommittee.

Before coming to their final decision the subcommittee on generators, motors and transformers conferred with the subcommittee on electrical tramways, of which Mr. A. P. Trotter is chairman, and a joint meeting took place, with the result that the pressure of 500 volts, which most concerned the latter subcommittee, was agreed to, and in addition to the pressures already agreed to 600 volts was decided upon as the standard pressure for electrical railways.

The question of the adoption of standard frequencies, although of equal importance with that of standard pressures, was not surrounded with the same difficulties. It was, however, deemed advisable to fix upon the standard frequencies at the earliest possible stage of the work, as no progress could be made in the standardisation of prime movers for driving alternate current machinery until such time as the frequencies had been settled upon. On this question there appeared to be a great preponderance in favour of frequencies of 25 and 50. The only point upon which any serious difference of opinion appeared to exist was the advisability of the adoption of a third frequency of 40 or 42, to enable rotary converters to be used to the fullest advantage. All the arguments in favour of this third frequency were fully discussed, but after carefully weighing the *pros* and *cons* the subcommittee decided not to recommend the adoption of more than two frequencies, namely, 25 and 50.

The recommendations of the subcommittee were then submitted to the electrical plant committee, the publication committee, the main committee, and the Board of Trade for their approval.

This having been obtained, it was deemed advisable, in the interests of the electrical industry of the country, that the findings on the questions of direct current pressures and frequencies should be published at an early date, without waiting for the completion of the entire report to be issued at a later date.

The following are the resolutions on standard direct current pressures and standard frequencies:—

(1) That the standard direct current pressures, measured at the consumers' terminals, be:—

110, 220, 440, 500 volts.

(2) That the standard direct current pressures, measured at the terminals of the motors, be:—

For tramways 500 volts.
For railways 600 volts.

(3) That 25 periods per second be the standard frequency for:—

(*a*) Systems involving conversion to direct current by means of rotary converters.
(*b*) Large power schemes over long distances.
(*c*) Three phase railway work, where motor gearing and the inductive drop on the track rail have to be considered.

(4) That 50 periods per second be the standard frequency for:—

(*a*) Mixed power and lighting on town supply mains.
(*b*) Ordinary factory power plant.
(*c*) All medium size power plant where rotary converters are not employed.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

THE present transitional phase of geographical thought and activity was faithfully mirrored in the proceedings of Section E. The majority of the papers revealed the wide range of geographical interests rather than any great advance in geographical coordination. In this they are typical; for while there are many workers at geographical problems, few, if any, would put forth the claim of being complete geographers. There are indications of many geographical specialisms being recognised. Their exponents are, however, at one disadvantage when compared with other specialists. An organic chemist usually has had a thorough training in chemistry before he specialises in organic chemistry. Few geographical specialists have had any training as geographers. Each makes his own contribution, but it is often an isolated one, and does not fit into a general plan of the subject. The unity of geography and the relation of its parts are very gradually being elucidated. The want of this coordination is strongly felt by most geographical workers. At the conclusion of the Southport meeting one wished for a summary coordinating the communications discussed. Perhaps this is felt though to a less extent, in other sections, and it would be useful if the presidential duties were made to conclude by the giving of a brief review of the work done at the section.

The address of the genial president, Captain Creak, was the only one which surveyed the whole world. It was on terrestrial magnetism, and has already been printed. Dr. Vaughan Cornish's researches, summarised in the report of the committee on terrestrial surface waves, are on world-wide phenomena, which he illustrated on this occasion mainly by beautiful views of the wave forms of Niagara, from which he has recently returned, and by pictures of wave forms in snow and on quarry roads caused by heavy sledge traffic.

The section was also privileged to hear an address from Prof. Pettersson, of Stockholm, who spoke for an hour in excellent English, on the effect of ice melting on oceanic circulation. Prof. Pettersson has long insisted that the thermodynamic cycle of latent heat, consisting of ice formation in polar regions and of ice melting in sea-water in lower latitudes, was a potent cause of oceanic currents. He has calculated that the ice melting between Iceland and Jan Mayen generates about 400,000 horse-power annually, which is expended in accelerating the water movements of the east Iceland polar current. The energy set free on ice melting in sea-water maintains a kind of inverted waterfall, an upwelling of bottom water to the surface. Warm currents follow the trend of deepest isobaths, ice currents exist only in shallow seas, where no warm current can melt them. Ice currents and warm currents meet between Iceland and Jan Mayen, west of Spitsbergen, south-east of Newfoundland, and round the margin of the ice-girdled Antarctic. The "outbursts" of Antarctic icebergs which carry them to low latitudes in the Indian Ocean may influence the climate of India and Australia. The latest Antarctic outburst and series of great droughts in India occurred between 1891–98. Prof. Pettersson considered that regular surface observations between 60° and 100° E. and a few series of deep-sea soundings would reveal hydrographical variations with important meteorological bearings. He also pointed out that current measurements at depths of 800–4000 metres in the Atlantic were needed to ascertain the significance of the currents generated by ice attraction. At the conclusion of his paper Prof. Pettersson showed in miniature an experiment to illustrate the effect of melting ice in causing currents in salt water carried out by Mr. J. W. Sandström, assisted by Miss A. Palmquist, who have made a series of useful calculations from the data obtained from this experiment.

Travellers' tales were few, but full of human interest. No one who heard Lieutenant Shackleton will forget the vivid and racy account he gave of the National Antarctic Expedition. Dr. Tempest Anderson's slides and descriptions of the volcanic phenomena of St. Vincent and Martinique were equally effective. Lieut.-Colonel Manifold described his journeying from India across China, and back over different routes through the heart of the Empire. In his paper were many hints of the great activity of other Powers

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than Britain in pushing on railway construction and promoting the expansion of their commerce. Dr. H. O. Forbes read a report on the work of his expedition to Sokotra. Dr. J. P. Thompson, the energetic Queensland geographer, contributed a comprehensive account of the geography of the State.

Exploration is now no longer confined to foreign lands, and some of the younger botanists have shown us what can be done when the plant world at home is regarded geographically. From the point of view of pure science they are making an important contribution to the study of the relationship between organisms and environment, and compiling part of the data necessary for the study of macro-organisms—the complex associations of rock, air, water, and organic life considered as a whole, which are the subject-matter of the geographer. From the point of view of applied science they are carrying out an equally valuable work, for a knowledge of the characteristics and distribution of the different plant associations is the best clue to the possibilities and limits of their profitable exploitation for the production of economically important plants and animals. Such botanical surveys might well be subsidised by the Board of Agriculture. The example of the Canadian Geological Survey might be followed, and the work be entrusted to teachers of botany who would carry it out in their vacations.

Dr. Otto Darbishire, of Owens College, discussed the general problem of the relations of botany and geography, and insisted on the necessity for modern travellers having a knowledge of ecology. Dr. W. G. Smith, of the Yorkshire College, who has carried on the work of his deceased brother, who planned a botanical survey of Great Britain, also urged the importance of the observation and mapping of vegetation features in geographical exploration, and illustrated his thesis by reference to the maps already made for Britain. The maps made of the plant associations of the Eden, Tees, Tyne, and Wear basins by Mr. F. J. Lewis, of University College, Liverpool, were shown and described, and Mr. Moss discussed the age and origin of the peat moors of the southern Pennines.

One of the applications of botanical geography to practical affairs was well illustrated in a valuable paper by the chief engineer of the Liverpool Waterworks, Mr. Parry, who has been the pioneer in the afforestation of the catchment areas of water reservoirs, which has been proved to increase the purity of the water supplied to the citizens and to protect their pockets. Mr. E. D. Morel also discussed a problem in applied geography. He pointed out the value of West Africa for the production of raw cotton, and the results that had been obtained by appealing to the commercial instincts of the natives instead of having recourse to coercion. The importance of a study of native land and administrative systems was emphasised.

Mr. E. A. Reeves read a timely paper on the nature of geographical surveying suited to present requirements, when route charts must be replaced by maps based on surveys planned on scientific lines, while not so elaborate or accurate as large trigonometrical surveys. Mr. E. Heawood contributed the one paper on the history of geography. He discussed the newly discovered maps of Henricus Glareanus, who first described a convenient method for constructing the gores of a globe. One of his maps is the earliest known which shows a hemisphere on an equidistant polar projection.

The geography and education sections held a joint sitting to discuss geographical education. Mr. H. J. Mackinder opened with an eloquent exposition of the regional method of teaching geography and of the possibility of weaving into the regional treatment so much as is needed of other sciences by taking these one at a time in the successive stages of the strictly geographical argument. He submitted that geography could be placed in its rightful position only by the simultaneous application of a four-fold policy:—(1) The encouragement of university schools of geography where geographers should be made, of whom many would become secondary teachers; (2) the appointment of trained geographers as teachers in our secondary schools, either for geography alone or for geography and general help in other subjects; (3) the general acceptance of a progression of method in the subject, not expressed in detailed syllabuses issued by the State or other dominant authority which would tend to stereotype teaching, but in a tradition similar to that which at different times has governed the teaching of language and mathematics; (4) the setting of examinations by expert geographical teachers.

Mr. Hugh Richardson gave a valuable account of how he taught his pupils from thirteen to seventeen years of age the use of maps and books, and insisted on the value of laboratory work on which their books gave little help. Mr. Hewlett spoke of aims and difficulties in the teaching of geography, and Mr. Cloudesley Brereton of geography in secondary education.

In the discussion which followed, the main objections urged against Mr. Mackinder's ideas were that sufficient time was not allowed for carrying them out, and that it was impossible to adopt his suggestion that pupils should be grouped in special sets for the geography lessons. The need for teachers who have had a training in geography, and the value of geography as a coordinating subject in the curriculum, seemed to be recognised by all.

A. J. H.

ENGINEERING AT THE BRITISH ASSOCIATION.

THE section had a lengthy programme to work through at Southport, but it must be confessed that there were but few papers of outstanding importance.

On Thursday, September 10, after Mr. Hawksley's presidential address, which naturally dealt mainly with the problem of the supply of water to cities and villages, a paper was read by Mr. C. A. Brereton on the new King Edward VII. bridge over the River Thames, at Kew. The author showed some interesting lantern slides to explain more clearly the method of construction adopted in previous bridges which crossed the river at this site, and also in the case of the new structure. It was not until 1892 that, induced by the increase in the traffic and the inconvenience caused by the narrowness of the old bridge and the steepness of its gradients, the County Councils of Surrey and Middlesex decided to take steps to replace the bridge by a new one; the necessary Act of Parliament was eventually obtained in 1898, the contract was then let to Mr. Gibb, and the work was begun at once.

The bridge consists of three elliptical arches, the centre one being of rather longer span than the two side arches; it has a span of 133 feet, and a headway of 20 feet above Trinity high-water mark, while the two side spans are only 116 feet 6 inches in span, with a headway of 17 feet. The piers from which these three arches spring are carried down into the solid London Clay at a depth of 18 feet below the bed of the river. The width of the carriage way is 36 feet, and there are 9 feet 6 inch footways on either side; the maximum gradient is only 1 in 40. The whole of the arches, and the exterior of the piers, is constructed of solid granite, chiefly Cornwall and Aberdeen, many of the big stones weighing as much as 8 tons each. To provide for the traffic during the construction of the new bridge, a temporary timber bridge was put up alongside the old one; this was completed in the remarkably short time of six months. The cofferdams for the piers of the new bridge were started in December, 1899, and but little difficulty was met with in their construction. All three arches were constructed simultaneously, and therefore it was necessary for all the stones for the arches to be brought on to the ground before the turning of the arches was commenced; every stone was numbered and placed in the receiving yard ready to take its place in the work. The masonry of the arches was commenced in May, 1902, and completed in December of that year—an extremely expeditious piece of work. The total length of the bridge proper is 502 feet, the approaches on the Middlesex and Surrey sides bringing the overall length to 1182 feet. The bridge was opened by His Majesty the King on May 20 last, having taken about three and a half years to construct; one year was occupied in the construction of the temporary bridge and the removal of the old bridge.

The only other paper dealt with on the Thursday was an interesting contribution by Mr. J. Harrison—illustrations of graphical analysis. The author gave an account of a simple graphical method of obtaining equations for the displacement of the valve, and for the sliding of the block in the link in an ordinary Stephenson's link gear. In fact, it

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